CLAIMS

What is claimed:

1. A photonic crystal structure, comprising:

a substrate having a surface characteristic; and

at least a first material disposed on the surface characteristic and conformally covering the surface.

2. The photonic crystal structure of Claim 1 wherein the first material is disposed using supercritical fluid deposition processes.

3. The photonic crystal structure of Claim 1 wherein the surface characteristic is a patterned substrate.

4. The photonic crystal structure of Claim 1 wherein the first material comprises one of at least a metal, a semiconductor, a polymer, a monomer, a mixture of metals, a metal dioxide, a metal sulphide and metal alloys.

5. The photonic cyrstal structure of Claim 3 wherein the patterned substrate has submicron features.

6. The photonic crystal structure of Claim 5 wherein the features have an aspect ratio of between approximately twenty and thirty.

7. The photonic crystal structure of Claim 1 wherein the substrate is one of a silicon wafer, and a silicon wafer having a silicon dioxide cladding layer.

8. The photonic crystal structure of Claim 1 comprising a thin film filter.

9. The photonic crystal structure of Claim 1 comprising an integrated circuit.

10. An integrated waveguide device, comprising:

a substrate having a first refractive index characteristic;

a first material disposed on the substrate having a second refractive index characteristic, and forming a waveguide layer; and

a second material disposed at least within the first material having a third refractive index characteristic wherein the third refractive index characteristic is greater than the first and second refractive index characteristics.

11. The integrated waveguide device of Claim 10 further comprising a cladding layer disposed on the first material.

12. The integrated waveguide device of Claim 10 wherein the dimensions of the waveguide layer is approximately 6 x 6 μm^2.

13. The integrated waveguide device of Claim 10 wherein the second material is deposited in one of a plurality of at least holes, trenches and cylinders.

14. The integrated waveguide device of Claim 10 wherein the aspect ratio of the plurality of holes is approximately in the range of 20 to 30.

15. The integrated waveguide device of Claim 10 wherein the first material has at least one patterned array of submicron features such that the second material is deposited therein.

16. A photonic crystal filter, comprising:

an input waveguide which carries a signal having at least one frequency including at least one desired frequency;

an output waveguide; and

a photonic crystal resonator system coupled between said input and output waveguides operable for the adjustable transfer of said at least one desired frequency to said output waveguide.

17. The photonic crystal filter of Claim 16 wherein the filter is a fixed single-wavelength filter.

18. The photonic crystal filter of Claim 16 wherein the filter is tunable for at least one of wavelength and polarization.

19. The photonic crystal filter of Claim 16 wherein the photonic crystal resonator system is a multi-cavity Fabry-Perot resonator.

20. The photonic crystal filter of Claim 16 wherein the photonic crystal resonator system is a single cavity Fabry-Perot resonator.

21. The photonic crystal filter of Claim 16 wherein the photonic crystal resonator system comprises a first photonic crystal mirror and a second photonic crystal mirror, the second photonic crystal mirror being spaced from the first photonic crystal mirror to form a resonant cavity.

22. The photonic crystal filter of Claim 21 wherein the first and second photonic crystal mirrors include a two-dimensional hexagonal structure.

23. The photonic crystal filter of Claim 21 wherein the first and the second photonic crystal mirrors include a three-dimensional structure.

24. The photonic crystal filter of Claim 16 wherein a change in a refractive index characteristic of the photonic crystal resonator system provides for tuning of the filter.

25. The photonic crystal filter of Claim 24 wherein the refractive index can be controlled by using one of at least thermal-optics, electro-optics, magneto-optics and piezo-optics means.

26. The photonic crystal filter of Claim 16 wherein said photonic crystal resonator system comprises a photonic crystal that is a three-dimensionally periodic dielectric structure.

27. The photonic crystal filter of Claim 16 wherein said photonic crystal resonator system comprises a photonic crystal that is a two-dimensionally periodic dielectric structure.

28. The photonic crystal filter of Claim 16 wherein the photonic crystal resonator system comprises a one-dimensionally periodic photonic crystal.

29. A photonic crystal wavelength router, comprising:

at least a first input waveguide;

at least a first output waveguide;

a chromatic dispersion compensator;

at least one wavelength division multiplex filter; and

at least one photonic crystal reflector.

30. The photonic crystal wavelength router of Claim 29 further comprising a power tap disposed therein.

31. The photonic crystal wavelength router of Claim 29 wherein the router comprises a material with tunable dielectric or absorbing properties.

32. The photonic crystal wavelength router of Claim 29 comprises one of at least a one-dimensionally periodic photonic crystal, a two-dimensionally periodic photonic crystal and a three-dimensionally periodic photonic crystal.

33. A photonic crystal optical add/drop multiplexer, comprising:

an input waveguide;

at least a first output waveguide;

an optical performance monitor coupled between the input waveguide and the at least first output waveguide;

a photonic crystal wavelength router; and

a dispersion compensation module.

34. A photonic crystal dynamic optical add/drop multiplexer comprising:

a plurality of input waveguides;

a plurality of output waveguides;

a plurality of photonic crystal resonator systems disposed between the plurality of input waveguides and plurality of output waveguides; and

a photonic crystal reflector coupled to the plurality of photonic crystal resonator systems.

35. A method of producing an integrated photonic circuit device, comprising:

providing a substrate with a surface characteristic and a first refractive index characteristic;

disposing at least a first material with a second refractive index characteristic onto the surface characteristic, wherein the second refractive index characteristic is higher than the first.

36. The method of producing an integrated photonic circuit device of Claim 36 further comprising:

etching the surface characteristic of the substrate to form a plurality of cavities having an aspect ratio characteristic; and

depositing a second material having a third refractive index characteristic in the plurality of cavities, the third refractive index characteristic being higher than the first and the second refractive index characteristic.

37. The method of producing an integrated photonic circuit device of Claim 37 wherein the aspect ratio characteristic is approximately 30.

38. A periodic three dimensional photonic crystal structure comprising:

a substrate having a surface characteristic;

at least one thin film deposited on the surface characteristic to result in a multi-layer photonic crystal, the multi-layer photonic crystal being adapted to

have an induced variation in an index of refraction characteristic and wherein a plurality of the multi-layer photonic crystals are placed in a stack configuration and a material is deposited into interstitial gaps formed in the stack configuration using supercritical fluid deposition processes.

39. The periodic three-dimensional photonic crystal structure of Claim 38 wherein the substrate is spherical in shape.

40. An optical waveguide structure, comprising;

a first waveguide;

a second waveguide that intersects with said first waveguide; and

at least one photonic crystal resonator at the intersection of said first and second waveguides to minimize cross talk between signals of said first and second waveguides.